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ABSTRACT

This document is the instructor's manual for a course in mathematics for water quality control personnel. It is designed so a program may be designed for a specific facility. The problem structures are arranged alphabetically by treatment process. Charts, graphs and/or drawings representing familiar data forms contain the necessary information to perform the required calculations. Treatment processes covered include: (1) activated sludge; (2) analyses; (3) chlorination; (4) flow measurement; (5) population equivalent; (6) pumping station; (7) screening; and (8) thickening. (CS)

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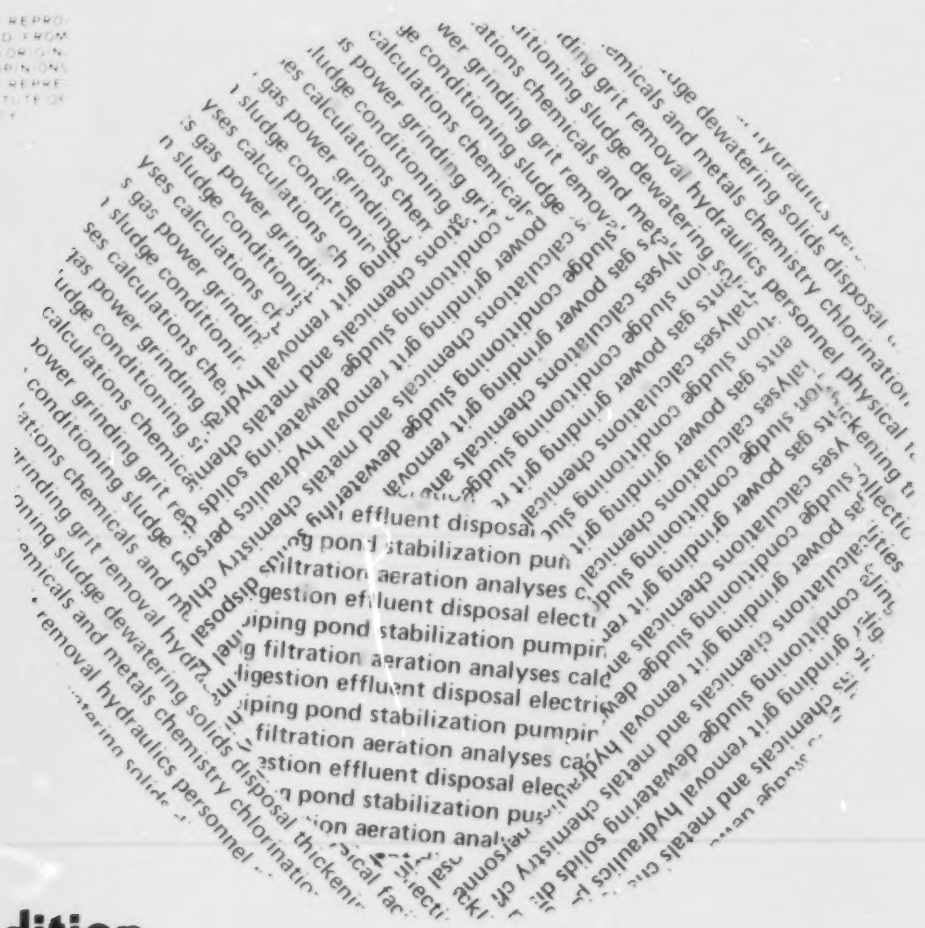

Second Edition

MATH PROBLEMS FOR WATER QUALITY CONTROL PERSONNEL

Instructor's Manual

SE 026 868

5.00

MATH PROBLEMS
For Water Quality Control Personnel
Second Edition

Fred Delvecchio
Gloria Brutsch

Environmental Systems Engineering
Clemson University
Clemson, South Carolina

1977

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Preface

In many instructional programs for water quality control personnel, mathematics proves to be one of the most difficult courses for the student. Failure rates are high, relevant problems are difficult and instructors are at a loss when trying to apply mathematical principles to the water quality control field. This edition of Math Problems for Water Quality Control Personnel will assist the mathematics instructor with little experience in the field, the technical instructor with field experience lacking confidence as a mathematics instructor and the operator with a need to improve his or her mathematical skills.

For the first edition, the authors reviewed 54 manuals now used in instructional programs and found that design problems are used to train and test operators. Since operators do not need to master such mathematical calculations, the authors turned from standard references and to active operators to find problems reflecting day-to-day mathematical demands placed on plant personnel. This second edition is the result of operators' contributions to the first edition.

The authors have tried to present the problems in this edition using data as it appears in the treatment plant. Consequently, the number of words in each problem statement has been held to a minimum. To every possible extent, efforts have been made to eliminate the "storybook approach" to problems because such an approach does not produce an accurate representation of how an operator sees information in a plant.

Editing, organization and production of this manual was ably provided by Jack A. McKenzie, editor; Clay Duffie, illustrator; Marie Sims and Patsy Phillips, typists. Other valuable assistance was provided by Clemson University and its publications staff and Tom Hallman. The 77 problems contained in this book were selected by the authors after more than 1500 such items had been reviewed. A loose-leaf version of the chosen problems was prepared and field tested in a mathematics workshop sponsored by Clemson University's Office of Operator Training. Following this validation procedure, the final copy of the manual was done and sent to the printers. Keith Hoy and Andy Young gave significant assistance by proofing all the final problems for correct answers. The biggest thanks of all, however, must go to the numerous operators who submitted problems in response to the first edition.

Introduction

The manual before you is but one of two forms in which the second edition of Math Problems for Water Quality Control Personnel has been prepared. This is the instructor's version containing only problem statements; no data or answers are given. In this form, the manual has any number of uses in that individual problems can be adapted to meet a variety of needs.

An instructor needing outlines for problems to assign as classroom work or to include on examinations can select the problems he or she wants and fill in appropriate data. Under this system, an instructor can develop unlimited variations for any given problem. The same is true for certification boards looking for models for examination questions. A third potential user of the incomplete form is the plant supervisor faced with presenting on-the-job training programs. Since the supervisor would be familiar with the calculations required for operation of his or her plant and would have access to actual plant data, he or she could easily produce a mathematics training program specifically oriented to that plant.

A student workbook containing complete problems, answered and referenced, also has been prepared using the same problem statements as the ones in the instructor's manual. The workbook has been designed for the operator wanting to study on his or her own and for the instructor wanting an easy-to-use reference or textbook.

Any comments or suggestions for improving this manual or corrections in the text will be appreciated. Also, should the reader think of any problems that should be added, the authors ask that such items be put into the format used in the manual and mailed to Fred Delvecchio, Project Administrator, 401 Rhodes Engineering Research Center, Clemson University, Clemson, South Carolina 29631.

Instructions

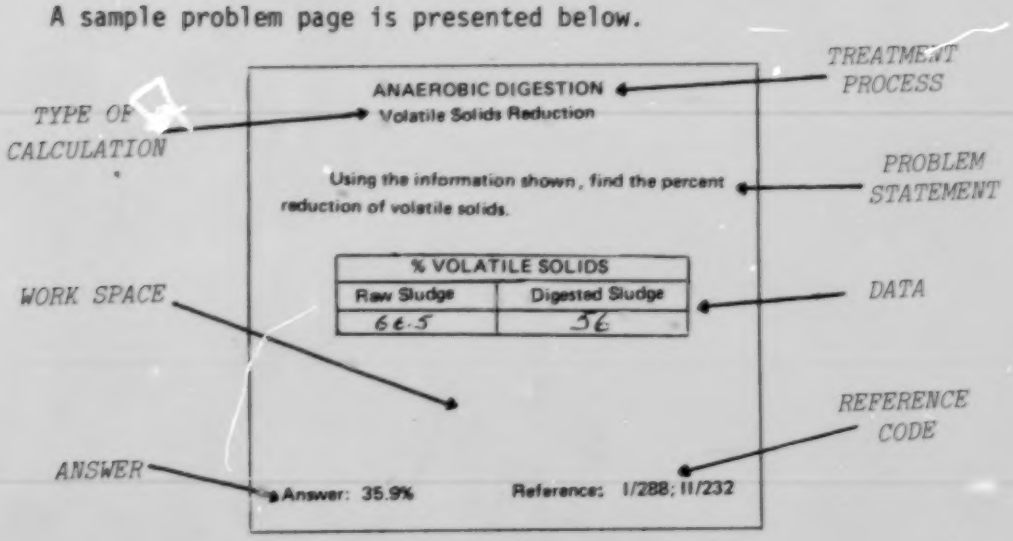
The problem structures in the text are arranged alphabetically by treatment process. Subheads serve as clues to what type calculations are required to work the problems. Charts, graphs and/or drawings representing data forms the operator might see in a plant should contain information necessary for performing the calculations required by the problems. The back of each page should be left blank to supplement the work space provided on the front. In the bottom left of each page place the correct answer to the problem on that page.

In the bottom right corner of each page is a coded reference keyed to the two-volume resource chosen by the authors. The resource is Mathematics for Water and Wastewater Treatment Plant Operators, Book I -- Fundamentals and Book 2 -- Advanced, by Joanne Kirkpatrick, State Water Resources Board, Sacramento, California. The books (copyright 1973) were published by Ann Arbor Science Publishers, Incorporated, Post Office Box 1425, Ann Arbor, Michigan 48106.

The reference code works as follows.

I/260 means Book 1/Page Number 260
II/205 means Book 2/Page Number 205

A sample problem page is presented below.



ACTIVATED SLUDGE

Air Requirement

Each pound of BOD going into an aerator needs cubic feet of air. Using this and the information shown, find the cubic feet of air required daily. Then find the cubic feet of air per minute required from the blowers.

Flow mgd	BOD mg/ℓ

Answer: cubic feet/day

cubic feet/min

Reference: I/260; II/205

ACTIVATED SLUDGE

Air Requirement

Using the information shown, fina the cubic feet of air applied for each pound of BOD.

FLOW mgd	PRI EFF BOD mg/ℓ	Air Flow x 1000 cu. ft./day

Answer: cu ft/lb BOD

Reference: I/260; II/205

ACTIVATED SLUDGE

Food/Organism Loading Ratio

Using the information shown, find the food/organism loading ratio.

FLOW mgd	PRI EFF BOD mg/ℓ	MLVSS mg/ℓ	AERATOR VOL. gals.

Answer:

Reference: I/233; II/173

ACTIVATED SLUDGE

Food/Organism Ratio

Using the information shown, find the food/organism ratio.

FLOW mgd	PRI EFF BOD mg/ℓ	MLSS mg/ℓ	MLVSS %	AERATOR VOL. gals.

Answer:

Reference: I/233; II/173

ACTIVATED SLUDGE

Mean Cell Residence Time

Using the information shown, find the mean cell residence time. The aerator holds million gallons and the final clarifier holds million gallons.

Suspended Solids mg/ℓ			Flow mgd	
Fin Eff	Waste Sludge	MLSS	Plant	Waste

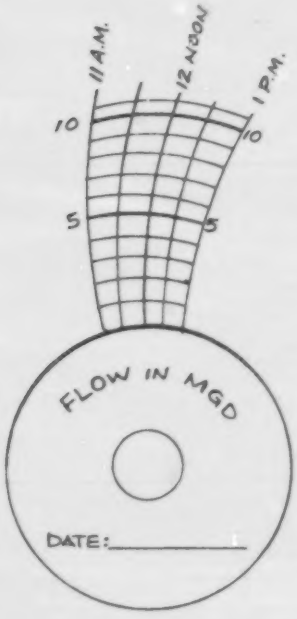
Answer:

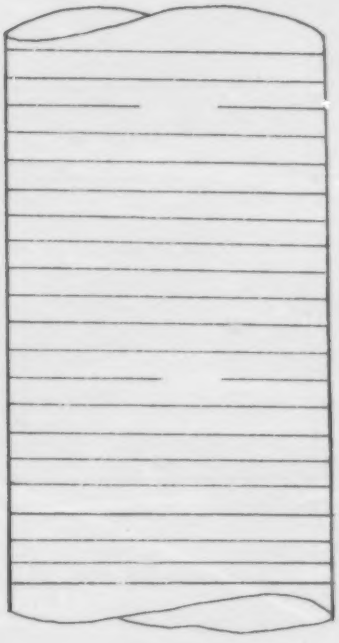
Reference: I/244; II/182

ACTIVATED SLUDGE

Return Sludge Pumping Rate

Using the information shown, find the return sludge pumping rate in gallons per minute.





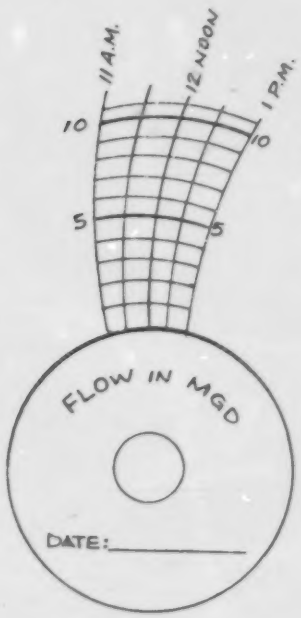
Answer: gpm

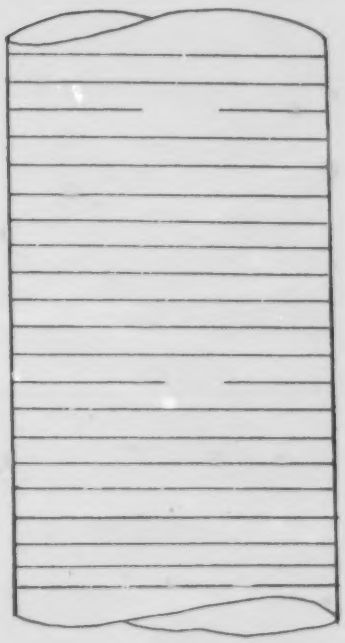
Reference: I/255; II/199

ACTIVATED SLUDGE

Return Sludge Pumping Rate

Using the information shown, find the return sludge pumping rate in million gallons per day.





Answer: mgd

Reference: I/255; II/199

ACTIVATED SLUDGE

Sludge Age

Using the information shown, find the sludge age in days for an aeration tank holding gallons.

FLOW mgd	PRI EFF SS mg/ℓ	MLSS mg/ℓ

Answer:

Reference: I/239; II/177

ACTIVATED SLUDGE

Waste Sludge Pumping Rate

Using the information shown, find the waste sludge pumping rate in gallons per day.

RETURN SLUDGE mg/ℓ	WASTE SLUDGE lb/day

Answer: gallons/day

Reference: I/252; II/195

ACTIVATED SLUDGE

Waste Sludge Pumping Rate

Using the information shown, find the waste sludge pumping rate in gallons per minute.

Waste Sludge		Remarks
mg/ℓ	lb/day	
		Waste sludge pump running minutes/hour

Answer: gpm

Reference: I/252; II/195

ANAEROBIC DIGESTION

Detention Time

Find the detention time in days for the raw sludge fed to the digester shown.

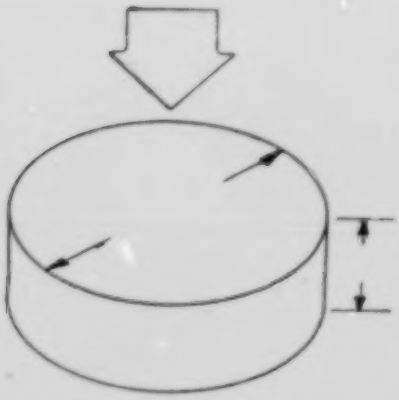
Answer: days

Reference: I/285; II/229

ANAEROBIC DIGESTION

Detention Time

Find the detention time in days for the raw sludge fed to the digester shown.



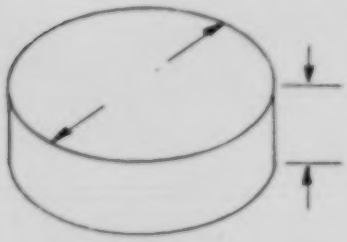
Answer: days

Reference: I/285; II/229

ANAEROBIC DIGESTION

Digester Loading

Using the information shown, find the pounds of volatile solids added per cubic foot of digester volume each day.



DIGESTER		
Raw Sludge gallons	% Solids total	% Solids volatile

Answer: lbs VS/cu ft

Reference: I/281; II/225

ANAEROBIC DIGESTION

Gas Production

Using the information shown, find the cubic feet of gas produced for each pound of volatile solids destroyed.

DIGESTER				
Raw Sludge gallons	% Solids total	% Solids volatile	Gas Produced cu ft	Volatile Solids reduction

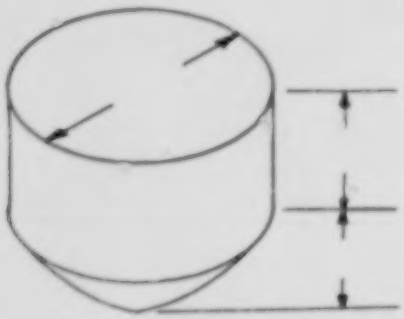
Answer: cu ft/lb VS

Reference: I/294; II/234

ANAEROBIC DIGESTION

Seed Sludge Volume

Find the gallons of seed sludge needed to fill the digester shown to percent of its volume.



Answer: gallons

Reference: I/275

ANAEROBIC DIGESTION

Seeding

You want to maintain a volatile-solids-loading ratio of pounds of seed volatile solids for each pound of volatile solids under digestion. Find the pounds of volatile solids the seed sludge should have under these conditions.

DIGESTER		
Raw Sludge gallons	% Solids total	% Solids volatile

Answer: lbs

Reference: I/276; II/221

ANAEROBIC DIGESTION

Volatile Solids Loading

A -gallon digester seems to operate best with a volatile solids loading of pounds per day per cubic foot. Using the information shown, find how many gallons of raw sludge can be pumped to this digester daily.

RAW SLUDGE	
% Solids total	% Solids volatile

Answer: gallons/day

Reference: I/281; II/225

ANAEROBIC DIGESTION
Volatile Solids Reduction

Using the information shown, find the percent reduction of volatile solids.

% VOLATILE SOLIDS	
Raw Sludge	Digested Sludge

Answer: %

Reference: I/288; II/232

ANAEROBIC DIGESTION

Volatile Solids Reduction

Using the information shown, find the pounds of volatile solids destroyed each day.

DIGESTER			
Raw Sludge gallons	% Solids total	% Solids volatile	% Reduction volatile solids

Answer: lbs

Reference: I/282; II/227

ANAEROBIC DIGESTION

Volatile Solids Reduction

Using the information shown, find the pounds of volatile solids destroyed for each cubic foot of a digester with a volume of cubic feet.

DIGESTER			
Raw Sludge gallons	% Solids total	% Solids volatile	% Reduction volatile solids

Answer: lbs/cu ft/day

Reference: I/283; II/227

ANALYSES

BOD, Milligrams per Liter

Using the information in the laboratory worksheet shown, find the BOD, milligrams per liter for the raw, primary effluent and final effluent samples.

BOD				
Sample	Blank	Raw	Primary Effluent	Final Effluent
Bottle number				
mℓ Sample				
Initial DO mg/ℓ				
5 Day DO mg/ℓ				

BOTTLE VOLUME = mℓ

Answers: Raw mg/ℓ

Primary Effluent mg/ℓ

Final Effluent mg/ℓ

Reference: I/340; II/257

ANALYSES

BOD, Percent Dilution

Using the information in the latoratory worksheet shown, find the percent dilution of the blank, raw, primary effluent and final effluent samples.

BOD				
Sample	Blank	Raw	Primary Effluent	Final Effluent
Bottle number				
mℓ Sample				

BOTTLE VOLUME = 300 mℓ

Answers: Blank %
Raw %
Primary Effluent %
Final Effluent %

Reference: I/340; II/257

ANALYSES

BOD Removal

Using the information in the laboratory worksheet shown, find the efficiency of the primary and secondary treatment processes and the overall plant efficiency.

BOD				
Sample	Blank	Raw	Primary Effluent	Final Effluent
Bottle number				
mℓ Sample				
Initial DO mg/ℓ				
5 Day DO mg/ℓ				

BOTTLE VOLUME = mℓ

Answers: Primary Efficiency %

Secondary Efficiency %

Overall Plant Efficiency %

Reference: I/203; II/134

ANALYSES

Expressing Concentration

Write mixed-liquor-suspended-solids concentration of percent as milligrams per liter.

Answer: mg/ℓ

Reference: II/251

ANALYSES

Expressing Concentration

Write a total-solids concentration of milligrams per liter as a percent.

Answer: %

Reference: I/251

ANALYSES

Expressing Temperature

Change the temperature shown on the celsius thermometer to the corresponding temperature in Fahrenheit.

Answer: degrees F

Reference: I/321

ANALYSES

Expressing Temperature

Change the temperature shown on the Fahrenheit thermometer to the corresponding temperature in celsius.

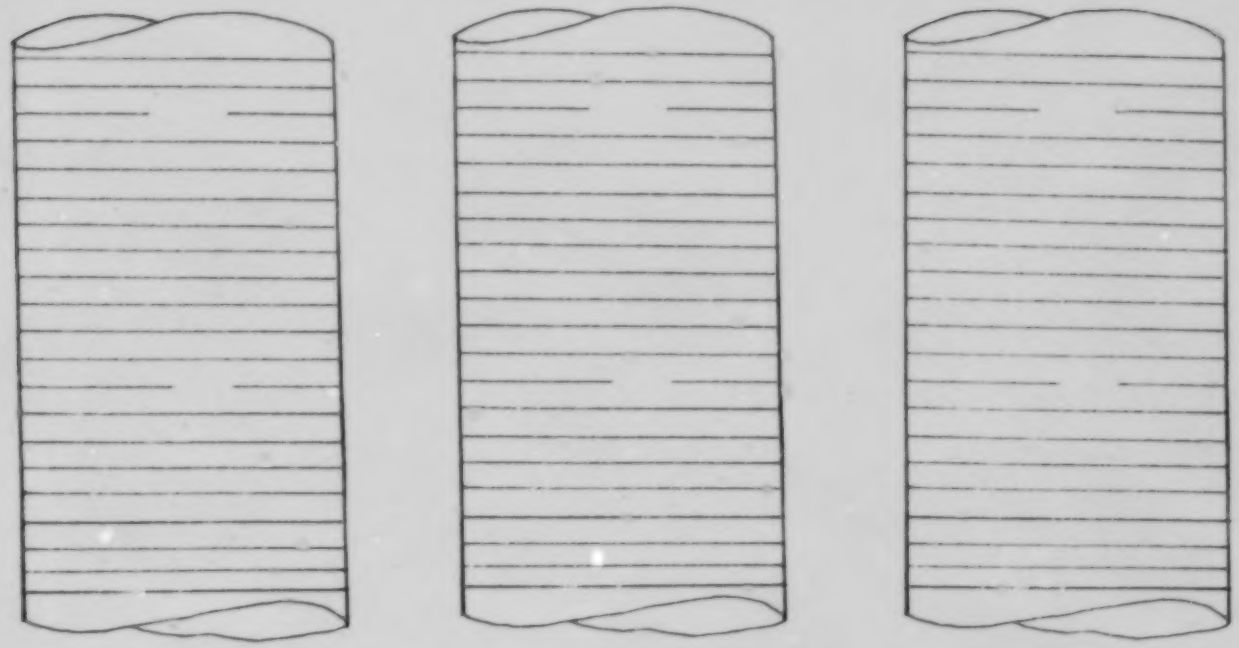
Answer: degrees C

Reference: I/321

ANALYSES

Settleability

A one-liter sample of mixed liquor settled to the levels shown. Find the percent of settled sludge for each time given.



Answer: minutes %

minutes %

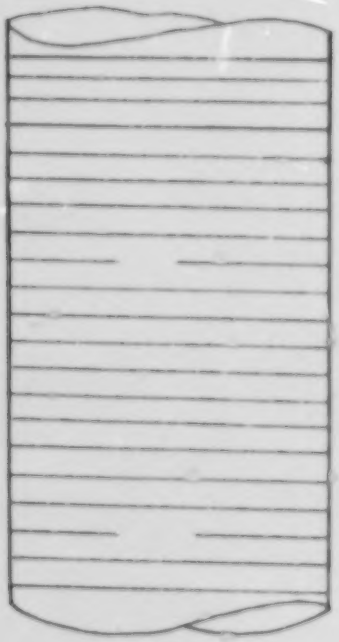
minutes %

Reference: I/333; II/252

ANALYSES

Sludge Density Index

A one-liter sample of mixed liquor settled to the level shown. Find the sludge density index if the mixed liquor suspended solids are milligrams per liter.



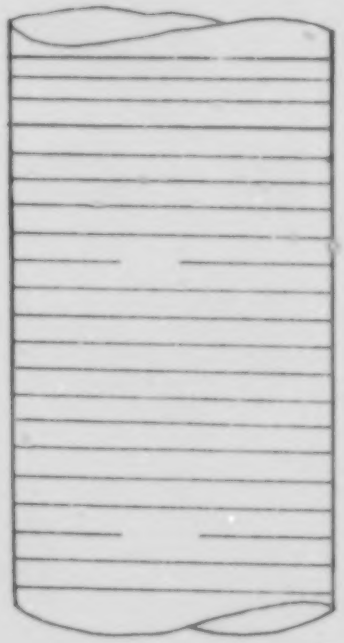
Answer:

Reference: I/339; II/255

ANALYSES

Sludge Volume Index

A one-liter sample of mixed liquor settled to the level shown. Find the sludge volume index if the mixed liquor suspended solids are milligrams per liter.



Answer: SVI =

Reference: I/335; II/293

ANALYSES

Suspended Solids, Milligrams Per Liter

Using the information in the laboratory worksheet shown, find the milligrams per liter suspended solids.

SUSPENDED SOLIDS	
Sample	Primary Effluent
Crucible number	
mℓ Sample	
Dry weight in grams	
Tare weight in grams	

Answer: mg/ℓ

Reference: I/329

ANALYSES

Suspended Solids, Percent Volatile

Using the information in the laboratory worksheet shown, find the percent volatile suspended solids.

SUSPENDED SOLIDS	
Sample	Primary Effluent
Crucible number	
mℓ Sample	
Dry weight in grams	
Tare weight in grams	
Ash weight in grams	
Tare weight in grams	

Answer: %

Reference: II/332

ANALYSES

Total Solids, Percent

Using the information in the laboratory worksheet shown, find the percent total solids.

TOTAL SOLIDS	
Sample	Raw
Dish number	
Wet weight in grams	
Tare weight in grams	
Dry weight in grams	
Tare weight in grams	

Answer: %

Reference: I/324

ANALYSES

Volatile Acid/Alkalinity Ratio

Using the information the laboratory worksheet shown, find the volatile acid/alkalinity ratio.

DIGESTER	
Volatile Acids mg/ℓ	Alkalinity mg/ℓ

Answer:

Reference: I/284; II/228

ANALYSES

Volatile Solids, Percent

Using the information in the laboratory worksheet shown, find the percent volatile solids.

VOLATILE SOLIDS	
Sample	Raw
Dish number	
Dry weight in grams	
Tare weight in grams	
Ash weight in grams	
Tare weight in grams	

Answer: %

Reference: I/324

CHLORINATION

Chlorine Demand

Using the information shown, find the chlorine demand in milligrams per liter.

CHLORINATION		
Cl2 Feed lbs/day	Flow mgd	Cl2 Residual mg/ℓ

Answer: mg/ℓ

Reference: I/306; II/241

CHLORINATION

Chlorine Demand Satisfied

The chlorine demand of a wastewater effluent is milligrams per liter. After chlorination, the chlorine demand is still milligrams per liter. Find the percent of the chlorine demand satisfied.

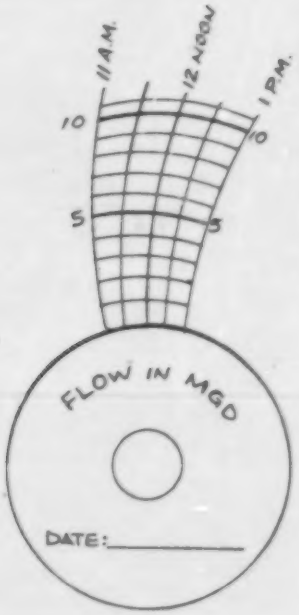
Answer: %

Reference: I/312; II/241

CHLORINATION

Chlorine Dosage

You must apply milligrams per liter of chlorine. Find the pounds per day of chlorine needed.

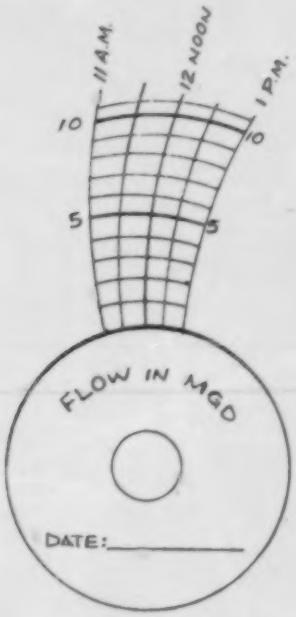


Answer: lb/day Reference: I/302; II/241

CHLORINATION

Chlorine Feed Rates

You must apply milligrams per liter of chlorine. Find the feed rate on the chlorinator in pounds per day.



Answer: lbs/day

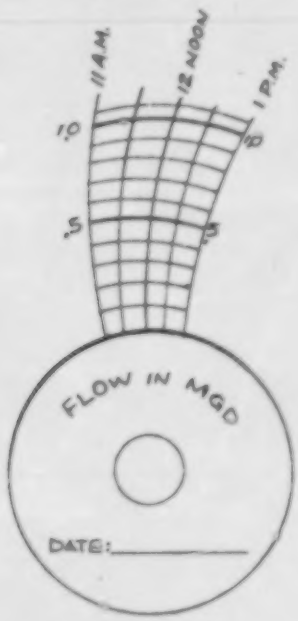
Reference: I/302; II/241

CHLORINATION

Hypochlorination

You want to apply milligrams per liter of chlorine. Using the information shown, find the pounds of calcium hypochlorite needed each day.

Net Weight	
Active Ingredient: Calcium Hypochlorite*	
Inert Ingredients	
*Available Chlorine	



Answer: lbs

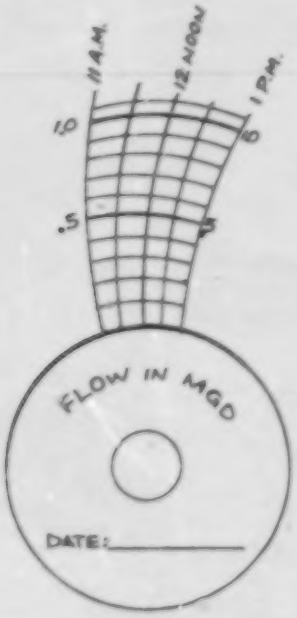
Reference: I/309; II/241

CHLORINATION

Hypochlorination

Find the pounds of hypochlorite used each day to give a milligrams per liter dosage of chlorine to a plant flow shown below.

Net Weight	
Active Ingredient: Calcium Hypochlorite*	
Inert Ingredients	
*Available Chlorine	



Answer: lbs

Reference: I/302; II/241

EFFLUENT DISPOSAL

Stream Dilution

A wastewater effluent with the flow and BOD_5 recorded in the report form shown flows into a stream. The stream has a flow of million gallons per day and BOD_5 of milligrams per liter. Find the BOD_5 in milligrams per liter of the combined stream and wastewater effluent flows.

EFFLUENT	
Flow mgd	BOD mg/ℓ

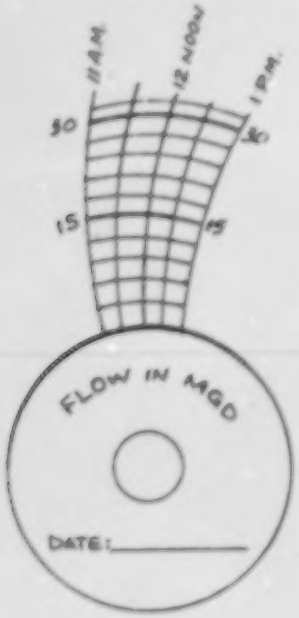
Answer: mg/ℓ

Reference: I/317; II/247

FLOW MEASUREMENT

Flow Composition

The flow chart shown indicates the average flow of a plant getting cubic feet per second of industrial waste from a cannery. Find the percent of the plant's daily flow from the cannery.



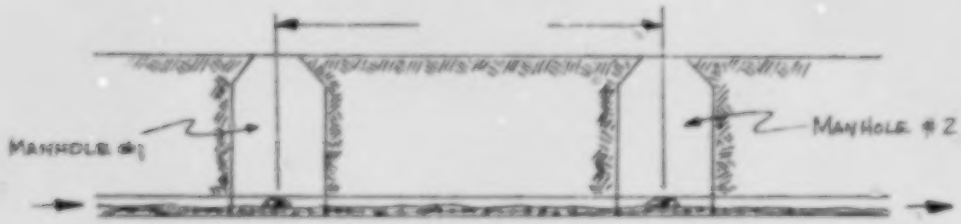
Answer: %

Reference: I/140; II/50

FLOW MEASUREMENT

Flow Velocity

At a.m. you dropped a float into one manhole shown. At a.m. the float reached the other manhole. Using the information shown, find the velocity of flow in feet per second.



Answer: ft/sec

Reference: I/143; II/62

FLOW MEASUREMENT
Open Channel Flow

Assume the plant flow meter is broken and you have to calculate the influent flow for plant records. A small stick you drop into the inlet channel floats the distance shown in seconds. Find the plant flow in million gallons per day.

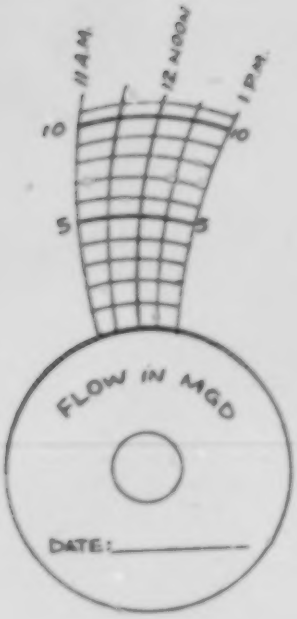
Answer: mgd

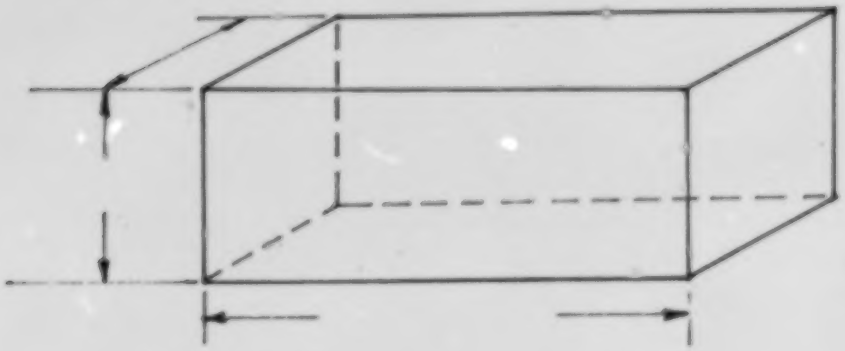
Reference: I/129; II/27

GRIT REMOVAL

Flow Velocity

Find the flow in feet per second through the grit chamber shown.





Answer: ft/sec

Reference: I/177; II/105

GRIT REMOVAL

Flow Velocity

A small stick dropped into the wastestream entering a grit chamber floats feet in seconds. Find the velocity of the wastewater in feet per second.

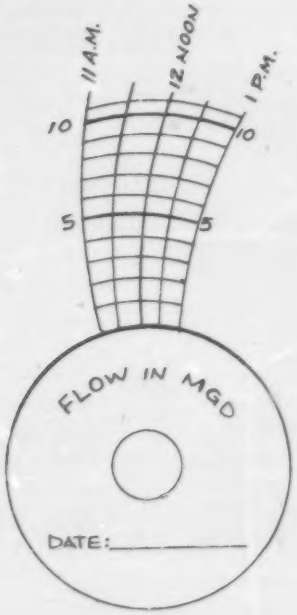
Answer: ft/sec

Reference: I/177; II/105

GRIT REMOVAL

Volume of Grit Removed

In 24 hours, a cart holding cubic feet of grit is used to haul two and one-half loads. Find the cubic feet of grit removed per million gallons per day.



Answer: cu ft/million gallons/day Reference: I/187; II/117

POPULATION EQUIVALENT

BOD

An industry contributes million gallons per day of an industrial waste with a BOD of milligrams per liter. Assuming pounds BOD per day per capital, find the population equivalent of this waste.

Answer: people Reference: I/173; II/100

POPULATION EQUIVALENT

Suspended Solids

A wastewater treatment plant receives gallons per day from an industry with suspended solids of milligrams per liter. Assuming pounds suspended solids per day per capita, find the population equivalent of this waste.

Answer: people Reference: I/173; II/100

PRIMARY SEDIMENTATION

Pumping Schedules

Using the information shown, find the minutes the raw sludge pump must run each day. The pump capacity is gallons per minute.

RAW SLUDGE PUMPED	
Gallons	Solids %

Answer: minutes/day

Reference: I/213

PRIMARY SEDIMENTATION

Sludge Pumping

Using the information shown, find the gallons of raw sludge that must be pumped to remove all the solids from the sedimentation tank.

RAW SLUDGE PUMPED	
Solids lbs	Solids %

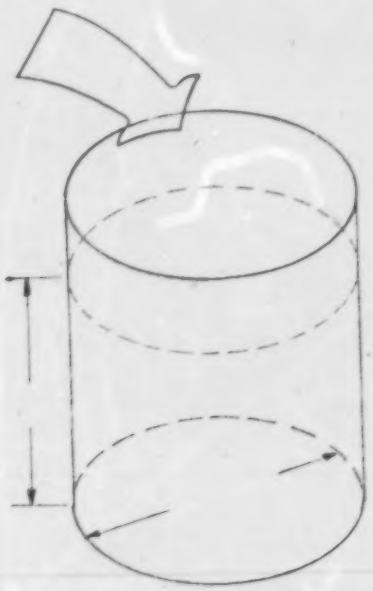
Answer: gallons

Reference: I/263; II/209

PUMPING STATIONS

Pump Capacity

The pump starts when the wastewater reaches a level of feet and stops when the level drops to feet. It takes minutes to pump this amount of wastewater from the wet well. Find the capacity of the pump if the influent flow rate to the wet well is gpm.



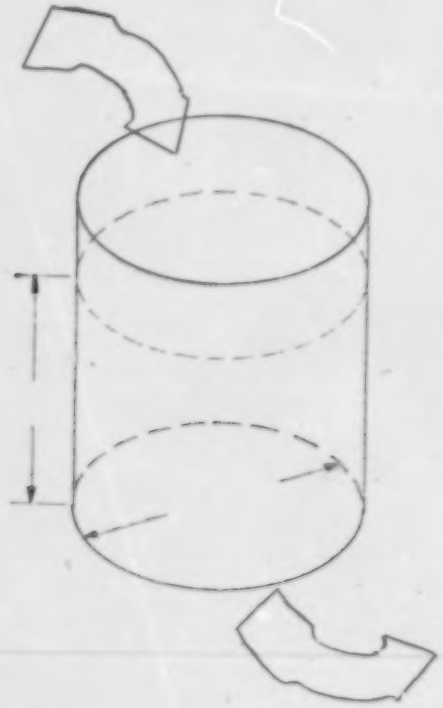
Answer: gpm

Reference: I/153; II/71

PUMPING STATIONS

Pumping Rate

Wastewater is entering the wet well at the rate of gpm. If the pump can deliver gpm, how long will it take to empty the full wet well?



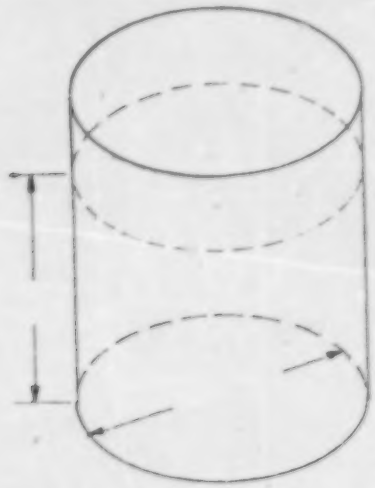
Answer: minutes

Reference: I/101, 153; II/71

PUMPING STATIONS

Wet Well Capacity

What is the capacity of the wet well in gallons?



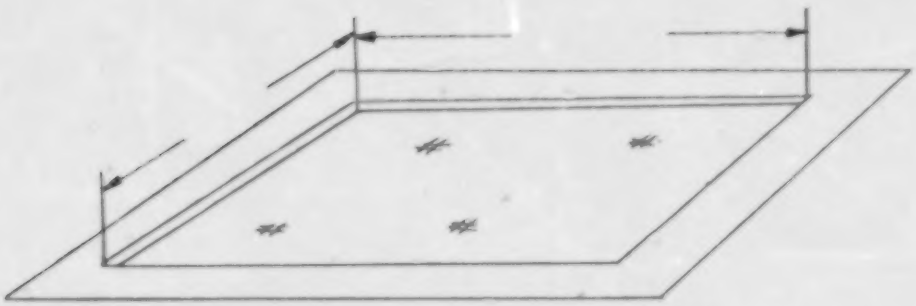
Answer: gallons

Reference: I/101

SAND FILTRATION

Cleaning Filter

Find the cubic feet of air required to clean the sand filter shown if cubic feet of air are needed for each square foot of filter surface area.

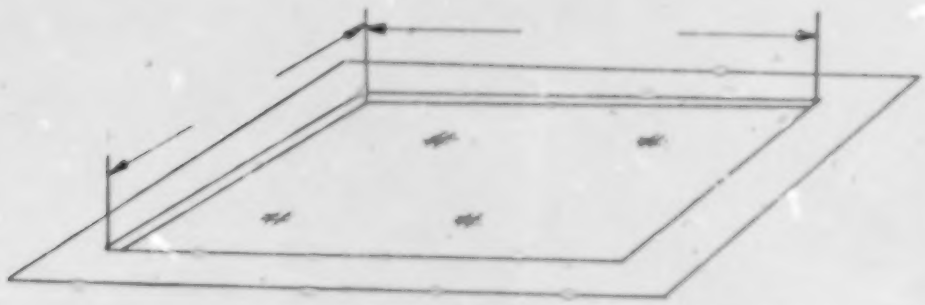


Answer: cubic feet Reference: I/314; II/245

SAND FILTRATION

Dosage

Find the dosage in gallons per hour per square foot to the rapid sand filter shown. The average daily flow is million gallons per day.



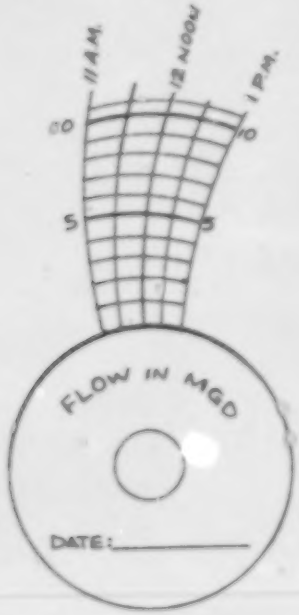
Answer: gph/sq ft

Reference: I/314; II/246

SCREENING

Screenings Disposal

A treatment plant with an average flow as shown below removes an average of cubic feet of screenings per million gallons of flow. The screenings are disposed of at a landfill. Estimate the landfill volume needed in cubic feet for a year.



Answer: cubic feet

Reference: I/175; II/101

SCREENING

Volume of Screenings

Using the information shown, find the volume of screenings removed per million gallons of flow.

FLOW mgd	SCREENINGS cu ft

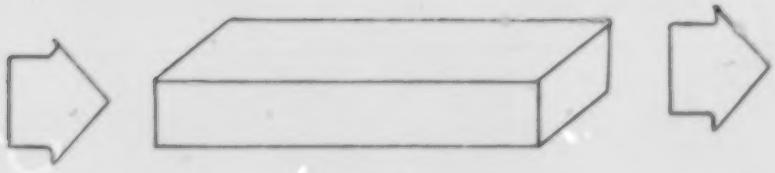
Answer: cu ft/million gallons

Reference: I/175; II/101

SEDIMENTATION

Detention Time

Find the detention time in hours for the sedimentation tank shown.



Answer: hours

Reference: I/193; II/125

SEDIMENTATION

Efficiency, BOD Removal

Using the information shown, find the percent of BOD removed by the sedimentation tank.

Raw BOD mg/ℓ	Primary Effluent BOD - mg/ℓ

Answer: %

Reference: I/202; II/134

SEDIMENTATION

Efficiency, BOD Removal

Using the information shown, find the pounds of BOD removed in the primary clarifier.

Flow mgd	5 Day BOD		
	Influent mg/ℓ	Effluent mg/ℓ	Removal %

Answer: lbs

Reference: I/205; II/139

SEDIMENTATION

Efficiency, Suspended Solids Removal

Using the information shown, find the efficiency of the sedimentation tank in removing suspended solids.

Raw Suspended Solids mg/ℓ	Effluent Suspended Solids mg/ℓ

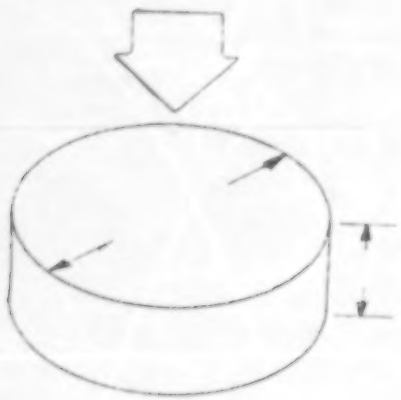
Answer: %

Reference: I/202; II/134

SEDIMENTATION

Surface Loading Rate

Find the surface loading rate in gallons per day per square foot for the sedimentation tank shown.



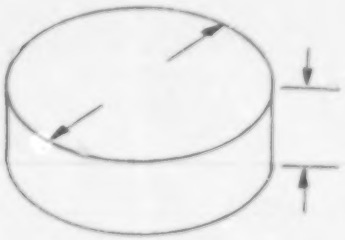
Answer: _____ gpd/sq ft

Reference: I/190; II/122

SEDIMENTATION

Tank Volume

Find the volume in million gallons of the clarifier shown.

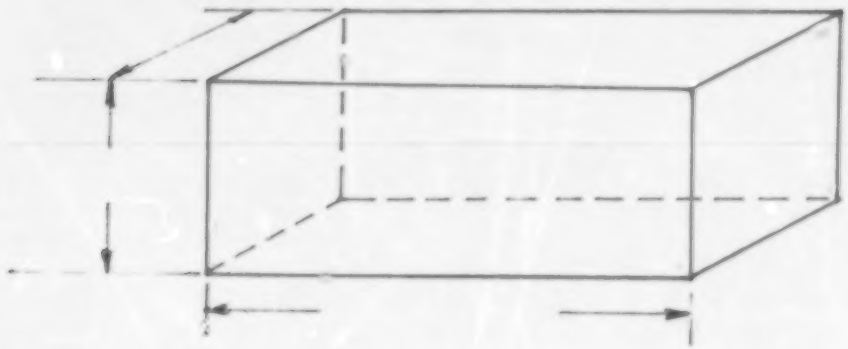


Answer: Million gallons Reference: I/189; II/119

SEDIMENTATION

Tank Volume

Find the volume in gallons of the clarifier shown.



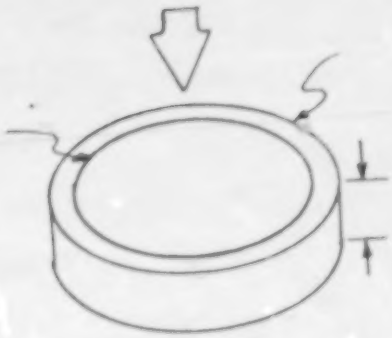
Answer: gallons

Reference: I/189; II/119

SEDIMENTATION

Weir Overflow Rate

Find the weir overflow rate in gallons per day per foot of the sedimentation tank shown.



Answer: _____ gpd/ft

Reference: I/199; II/131

THICKENING

Sludge Pumping

Using the information shown, find the gallons of thickened sludge that must be pumped to the digester from the thickener to move the pounds of solids.

RAW SLUDGE PUMPED		THICKENED SLUDGE PUMPED
Solids lbs	Solids %	Solids %

Answer: gallons

Reference: I/267; II/212

TRICKLING FILTER

BOD Removal

Using the information shown, find the pounds of BOD removed by the trickling filter each day.

FLOW mgd	INFLUENT BOD mg/ℓ	PRIMARY SEDIMENTATION % BOD Removal	TRICKLING FILTER % BOD Removal

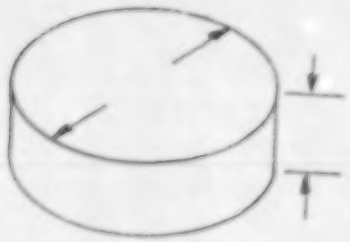
Answer: lbs

Reference: I/231; II/170

TRICKLING FILTER

Filter Capacity

Find the volume in acre-feet of the trickling filter shown.



Answer: acre-feet

Reference: I/221; II/152

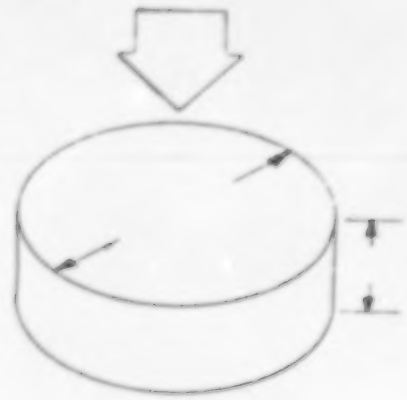
TRICKLING FILTER
Filter Capacity

Find the volume in cubic feet of the trickling filter shown.

Answer: _____ ft^3 Reference: I/221; II/152

TRICKLING FILTER
Hydraulic Loading

Find the hydraulic loading value in gallons per day per square foot of the trickling filter shown.

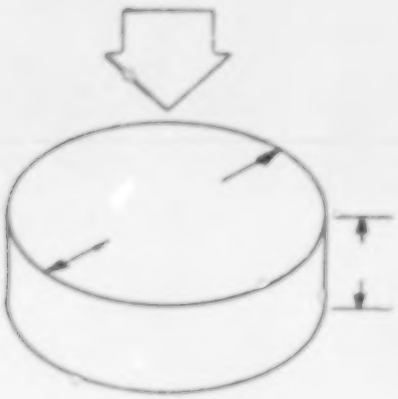


Answer: gpd/ft^2

Reference: I/225; II/156

TRICKLING FILTER
Hydraulic Loading

Find the hydraulic loading value in million gallons per acre per day of the trickling filter shown.



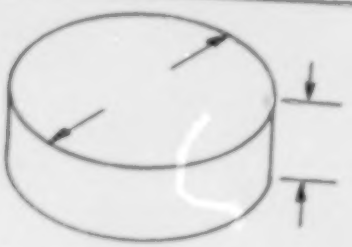
Answer: _____ mil-gal/acre/day

Reference: I/225; II/156

TRICKLING FILTER
Organic Loading

Using the information shown for the trickling filter, find the organic loading value, in pounds BOD per day per 1000 feet cubed.

FLOW mgd	INFLUENT BOD mg/ℓ



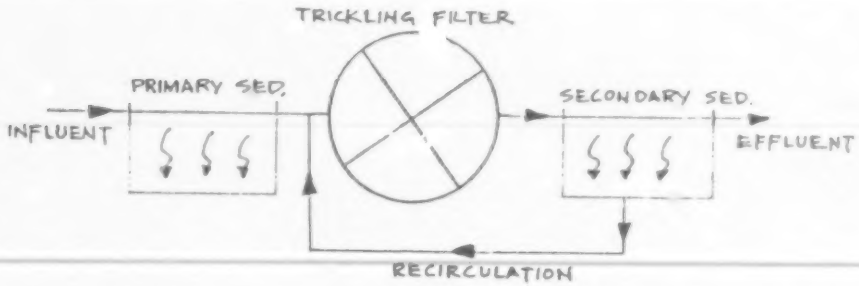
Answer: lb BOD/day/1000 ft^3

Reference: I/229; II/164

TRICKLING FILTER

Recirculation Flow

Find the recirculation flow in million gallons per day of the trickling filter plant shown. The recirculation ratio is



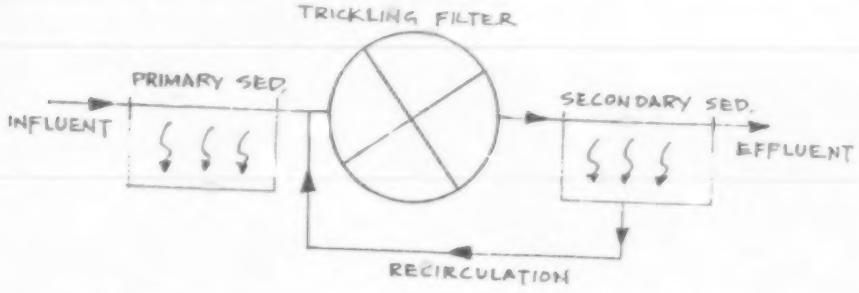
Answer: mgd

Reference: I/223; II/154

TRICKLING FILTER

Recirculation Ratio

Find the recirculation ratio of the trickling filter plant shown.



Answer:

Reference: I/223; II/154

TRICKLING FILTER

Suspended Solids Removal

Using the information shown, find the pounds of suspended solids removed by the trickling filter each day.

FLOW mgd	INFLUENT Suspended Solids mg/ℓ	PRIMARY SEDIMENTATION Suspended Solids % Removal	TRICKLING FILTER Suspended Solids % Removal

Answer: lb

Reference: I/231; II/170